Hindering Factors to the Utilisation of UAVs for Construction Projects in South Africa

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ABSTRACT
As the designs of construction projects become more complex, there is a corresponding increase in the difficulty encountered in project monitoring. Hence, it is advisable to integrate innovative technologies such as the use of an unmanned aerial vehicle (UAV) to abate some of the problems encountered in the delivery of construction projects. This paper aims to evaluate the barriers to the usage of UAVs in construction project delivery in South Africa. Adopting a quantitative method for the study, data was collected with the aid of a questionnaire from construction professionals in Gauteng province, South Africa. Findings from the study indicate that the most significant factors hindering the deployment of drones in the South African construction industry are lack of training by institutions and lack of investment in new technologies by organisations. Conclusively, the paper recommends measures that would propel the espousal of drone technologies for effective and efficient construction project delivery in the South African construction industry.

KEYWORDS
Barriers; Construction Projects; Project Monitoring; Unmanned Aerial Vehicles

INTRODUCTION
Globally, the construction industry is seen as a very complex, dynamic, and non-linear industry. Hence the pressure to deliver successful projects in the construction industry has turned into a worldwide issue (Ikuabe and Oke, 2019; Tengan and Aigbavboa, 2017). One of the prevailing issues plaguing the effective delivery of construction projects is project monitoring and assessment. Project monitoring and assessment have been viewed to be attributed to numerous obstructions in the construction industry because of their multifaceted nature. One peculiar characteristic of construction project monitoring and assessment is the paucity of technological innovations engaged in carrying out such functions (Petrov and Hakimov, 2019). This is partly due to the absence of innovation in the construction business coupled with the resistance to change within the construction industry. This has greatly inhibited the growth of the industry, resulting in unwanted eventualities which end up negating the anticipated objectives of the project.

Usually, construction projects encounter lots of uncertainties at distinctive levels of work, which leads to unsavory eventualities on the long term if not properly managed (Singh and Singh, 2002). To a very large extent, most of these daunting challenges are ushered in as a product of ineffective monitoring of the construction project, hence, bringing along its attendant consequences. Moreover, it is expedient that the monitoring of construction projects is effectively and adequately engaged to forestall the occurrence of these outcomes (Shivambu and Thwala, 2019). Numerous construction projects are still managed with the use of outdated methods and techniques which have done little to mitigate most of the prevailing shortcomings experienced in construction project delivery (Aghimien et al., 2018; Ikuabe et al., 2020). However, there seems to be a silver lining and some glimpse of hope with the advent of recent technological innovations. One such technology to help abate the challenges faced with construction project monitoring and assessment is drone technology or Unmanned Aerial Vehicles (UAVs).

Álvares et al., (2018) stated that UAVs represent one of the visual technologies being deployed for effective monitoring of construction projects. A drone or UAV is a vehicle that man does not board on, but it is controlled remotely by a person on the ground (Li and Liu 2018). UAVs are attributed with the ability to carry payloads such as cameras, visuals or infrared, and other sensors. These accompanying components aid in capturing data (digital images) of the targeted work section or process being engaged in. The use of this technological innovation would help in the engagement of effective and efficient monitoring of construction projects. Highlights of these are the improvement of the supply chain associated with construction project delivery, engaging in comprehensive site safety management, enforcement of quality management through the timely detection of defects, compliance of security measures on-site, and improvement of risk decisions (Goessens et al., 2018; Li and Liu, 2014; Dupont et al., 2017). This can be actualized through the implementation of UAVs for the delivery of construction projects. Based on the aforementioned benefits of the use of UAVs for construction management, this study is propelled towards assessing the inhibiting factors to the utilization of UAVs for the delivery of construction projects in South Africa.

THEORETICAL BACKGROUND

The construction industry is constantly experiencing difficulties in optimizing the current tool and methods in a way that they improve efficiency, productivity, and safety (Liu et al., 2016). The deployment of UAVs has been encouraged to help abate some of the challenges experienced in construction project delivery, with emphasis on construction project monitoring. However, some factors serve as an impediment to the integration of UAVs for construction monitoring and assessment. Weather condition poses a lot of challenge to UAVs which can lead to deviation from their predetermined path. According to Shakhatreh et al., (2019), UAVs can fail their mission due to bad weather conditions, and therefore not deliver on set goals. Also, UAVs are unable to operate in difficult weather conditions and under the high unsteady movement of air. Furthermore, it is difficult to obtain thermal images, and geo-referenced aerial images when at low flight levels (Krawczyk et al., 2015). Energy consumption is one of the challenges encountered with the usage of UAVs since they are mostly installed with low-capacity batteries, therefore limiting mission flights or time flight duration (Shakhatreh et al., 2019). The challenge of engaging in long-distance coverage is a setback to the deployment of drones for construction project monitoring. According to Paneque-Galvez et al., (2014), drones have a low endurance flight since they are small and equipped with small batteries that limit them to stay in the air for a long period while deployed for surveying functions.

Moreover, maintenance has also been noted to be a major challenge to drone utilization. Engaging in the repair of drones proves to be a difficult task due to the associated costs in carrying out such functions. Also, the change in illumination tends to impact the photogrammetric processing of UAVs' systems imagery negatively. Therefore, implying that the images that are captured in a sunny area will be different from those captured in a shaded area. This usually affects the automation of image matching algorithms which are both used in triangulation and digital elevation model generation (Whitehead and Hugennoltz, 2014). According to Federman et al., (2018), UAVs can easily suffer from signal jamming which may be caused by the interference system that uses frequency to operate, for example-, radio- and remote-controlled cars or model aircraft, this often serves as a challenge to using UAVs for project monitoring. Also, the cost engaged in deploying UAVs for construction project delivery serves as a barrier to its adoption. Generally, the various costs associated with engaging UAVs such as cost of purchase, cost of maintenance, personnel cost, operational costs e.t.c., do serve as inhibitors for its deployment for construction project assessment. Neil and Shield (2014) noted that the project cost can be significantly affected when UAVs that are rented are not optimally put to use. Also, the lack of well-trained personnel serves as a hindrance to the adoption of digital technologies for construction projects (Oke et al., 2018). This has a considerable negative influence on the espousal of technological innovation utilization for construction project delivery.

METHODOLOGY

The study assessed the barriers to the use of drones for construction project delivery in South Africa. In an attempt to attain the outlined objective of the study, a quantitative approach was adopted with the use of a questionnaire in eliciting a response from the target respondents. Ackroyd and Hughes (1981) noted that the use of questionnaires for the purpose of data collection has the attribute of reaching a large pool of respondents in a limited time frame. This informed the use of a questionnaire survey for the study. The study area was Johannesburg, Gauteng Province in South Africa. The choice of the study area stems from the fact that Gauteng is one of the chosen provinces in South Africa for construction activities; also, it boasts a large number of construction professionals. The target population of the study was construction professionals which are Architects, Quantity Surveyors, Engineers, Construction Managers, and Project Managers. The instrument for data collection was comprised of two sections, the former elicited responses based on the background information of the respondents, while the latter asked about the barriers to the utilization of drones for construction project delivery in South Africa. A 5-point likert scale was used for the questionnaire with 5 strongly agree, 4 agree, 3 being neutral, 2 being disagree and 1 strongly disagree. A total of one hundred and seventeen questionnaires were gotten from the respondents and were all filled appropriately for analysis. The method of data analysis used for the study was mean item score, standard deviation, and one-sample *t*-test. Also, the reliability of the research instrument was assessed with Cronbach's alpha test. This gave a value of 0.876, thus indicating good reliability of the research instrument (Tavakol and Dennick, 2011).

FINDINGS AND DISCUSSION

The review of the extant literature on the impediments to the usage of drone technology for construction project delivery revealed a total of fourteen variables. The study employed a one-sample *t*-test to determine the significance of the identified variables as rated by the respondents. Therefore, a null hypothesis was established which states that a variable is not important when the mean value is less than or equal to the population mean (H_0: $U \leq U_0$); while the postulated hypothesis states that a variable is important when the mean value is greater than or equal to the population mean (H_a: $U > U_0$). The population mean (U_0) was fixed at 3.50, while the significance of level of the individual variables was pegged at 95%, which according to Pallant (2005) is the conventional confidence level. This implies that a variable is deemed important when the mean value is equal to or above 3.50, while a variable is deemed not important when the mean value is less than 3.50. Table 1 indicates a two-tailed p-value portraying the significance of the identified barriers to the utilization of drones for construction project delivery.

Table 1. One-Sample Test

Barriers	Test Value = 3.50					
					95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	MD	L	U
Lack of training	17.426	116	.000	1.233	1.099	1.377
Project size	8.281	116	.000	1.067	.814	1.321
Low investment in technology	4.781	116	.000	.567	.336	0.809
Resistance to adopt new technologies	12.566	116	.000	1.150	.977	1.333
Data security and privacy issues	3.991	116	.000	.416	.208	0.626
High cost of technology	10.187	116	.000	.983	.791	1.188
Difficulties in proving track record of technology	4.369	116	.033	.367	.202	.531
Atmospheric challenges	7.618	116	.000	1.000	.741	1.267
Profitability worries	0.621	116	.000	.067	.155	0.289
Lack of technology understanding	3.123	116	.000	.333	.124	.555
Problem of interoperability	8.232	116	.000	.700	.538	.877
Maintenance of UAVs	7.620	116	.000	.417	.316	.532
Energy consumption	9.489	116	.000	1.067	.842	1.297
Lack of awareness	10.468	116	.000	.650	.564	.779

Note: MD=Mean Difference, L=Lower, U=Upper

Table 2 outlines the ranking of the hindering factors to the utilization of drone technology for the delivery of construction projects. The mean value of the variables is all above the cut-off point (3.50), thus indicating that all the identified factors are important based on the established hypothesis postulated for the study. Furthermore, it is observed that the *p*-value of the identified barriers is significant at a 95% confidence level by having a p-value of less than 0.05 excluding difficulties in proving track records of technology. Also, the findings indicated that the most significant barriers to the deployment of drone technology for construction project execution are Lack of training (*MIS=4.73, sig.=0.000*), Low investment in technology (*MIS=4.65, sig.=0.000*), project size (*MIS=4.57, sig.=0.000*), Ethical issues (*MIS=4.57, sig.=0.000), and Atmospheric challenges (MIS=4.50, sig.=0.000).*

The findings of this study indicate that the lack of training of personnel in handling digital technologies such as drones is one of the most prevailing impediments to its utilization in construction project delivery. This is in consonance with Oke et al., (2018) and Delgado et al., (2019) who affirmed that a major hindrance to the implementation of innovative technologies in construction processes and construction project delivery is the lack of requisite skills on the part of personnel involved in construction projects. Moreover, it is widely known that the paucity of the requisite knowledge and skills has served as a major hurdle for construction professionals and stakeholders in the ability to integrate digital technologies for construction project delivery. Furthermore, the study shows that low investment in digital technologies serves as an impediment to the attainment of the implementation of utilizing drone technologies for construction project delivery. This is affirmed by El-Masaleh et al., (2007) who observed that the construction industry as compared to other industries is not experiencing a high investment drive in digital technologies. Other sectors such as manufacturing, banking, and health have all taken the bull by the horn in committing huge financial investments in the attainment of digital technologies while the construction industry is lagging behind. One notable finding from this study is the insignificance of the difficulties of proving track records as an impediment to the usage of drone technology for construction project delivery. This is largely due to the fact that the evidence of the benefits of digital technologies are quite enormous and can be encountered in all spheres of life, construction inclusive. Hence, cannot be alluded to be a major hindrance to the espousal of drone technology for construction project delivery.

Table 2. Summary of t-test showing the rankings of the barriers of utilising drones for construction project delivery

Barriers	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)	Rank
Lack of training	4.73	.548	.071	.000	1
Low investment in technology	4.65	.709	.092	.000	2
Project size	4.57	.871	.129	.000	3
Data security and privacy issues	4.57	.998	.112	.000	3
Atmospheric challenges	4.5	1.017	.131	.000	5
High cost of technology	4.48	.748	.097	.000	6
Problem of interoperability	4.20	.659	.085	.000	7
Lack of awareness	4.15	.481	.062	.000	8
Resistance to adopt new technologies	4.07	.918	.119	.000	9
Energy consumption	3.92	.424	.105	.000	10
Maintenance of UAVs	3.92	.809	.055	.000	10
Difficulties of proving track record of technology	3.87	.650	.084	.033	12
Lack of technology understanding	3.83	.837	.107	.000	13
Profitability worries	3.57	.831	.107	.000	14

CONCLUSION AND RECOMMENDATIONS

The task of delivering construction projects within the ambits of outlined objectives still appears to be an uphill one. Construction monitoring and assessment are evidently one of the areas still posing challenges to efficient construction delivery. Hence, the call for the adoption and implementation of innovative technologies to help abate some of these daunting challenges. Based on this backdrop, this study empirically assessed the barriers to the utilization of drone technology or Unmanned Aerial Vehicles for construction project delivery in South Africa. Findings from the study showed that based on construction professionals' perception, the most significant impediments to the use of drone in construction projects is the lack of training on the part of personnel, low investment in technological innovations by stakeholders in the construction industry, the project size, data and privacy issues, atmospheric challenges, and the high cost of the technology. Based on the findings derived from the study, it is recommended that adequate requisite training and skill upscaling should be tremendously encouraged by relevant stakeholders in the construction industry. Furthermore, relevant practitioners in the construction industry should see investment in technological innovations as a way of surmounting the prevailing challenges being experienced in construction project delivery due to the inherent benefits from such espousal.

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